

What is Claimed Is

- [c1] 1. An electrolytic reactor for the electrocatalytic oxidation of chlorite ions in an aqueous solution, the reactor comprising:
 - an anode;
 - a cathode; and
 - a particulate catalyst material.
- [c2] 2. The electrolytic reactor according to Claim 1, wherein the catalyst material comprises a catalytic metal oxide and a support.
- [c3] 3. The electrolytic reactor according to Claim 2, wherein the support comprises a ceramic.
- [c4] 4. The electrolytic reactor according to Claim 2, wherein the support comprises a mineral particulate, a binder, silicon carbide, and a parting agent.
- [c5] 5. The electrolytic reactor according to Claim 2, wherein the catalytic metal oxide is about 0.01 to about 10% by weight of the support.
- [c6] 6. The electrolytic reactor according to Claim 2, wherein the catalytic metal oxide is about 0.05 to about 2% by weight of the support.
- [c7] 7. The electrolytic reactor according to Claim 1, further comprising a cation exchange material.
- [c8] 8. The electrolytic reactor according to Claim 7, wherein the cation exchange material forms a bottom layer, a mixture of the cation exchange material and the catalyst material forms an interlayer, and the catalyst material forms an upper layer.
- [c9] 9. An electrolytic reactor for the oxidation of chlorite ions in an aqueous solution, the reactor comprising:
 - an anode compartment comprising an anode and a catalyst material; and
 - a cathode compartment comprising a cathode.
- [c10] 10. The electrolytic reactor according to Claim 9, wherein the catalyst material comprises a catalytic metal oxide and a support.

[c11] 11.The electrolytic reactor according to Claim 10, wherein the support comprises a ceramic.

[c12] 12.The electrolytic reactor according to Claim 10, wherein the support comprises a mineral particulate, a binder, silicon carbide, and a parting agent.

[c13] 13.The electrolytic reactor according to Claim 10, wherein the catalytic metal oxide is about 0.01 to about 10% by weight of the support.

[c14] 14.The electrolytic reactor according to Claim 10, wherein the catalytic metal oxide is about 0.05 to about 2% by weight of the support.

[c15] 15.The electrolytic reactor according to Claim 9, further comprising a cation exchange material.

[c16] 16.The electrolytic reactor according to Claim 15, wherein the cation exchange material forms a bottom layer, a mixture of the cation exchange material and the catalyst material forms an interlayer, and the catalyst material forms an upper layer.

[c17] 17.An electrolytic reactor for the oxidation of chlorite ions in an aqueous solution, the reactor comprising:
an anode compartment comprising an anode;
a cathode compartment comprising a cathode; and
a central compartment disposed between the anode and cathode compartments, wherein the central compartment comprises a catalyst material.

[c18] 18.The electrolytic reactor according to Claim 17, wherein the anode compartment consists essentially of a cation exchange material.

[c19] 19. The electrolytic reactor according to Claim 17, wherein the cathode compartment consists essentially of a cation exchange material.

[c20] 20.The electrolytic reactor according to Claim 17, wherein the catalyst material comprises a catalytic metal oxide and a support.

[c21] 21.The electrolytic reactor according to Claim 17, wherein the catalyst material comprises a size of about 425 microns to about 600 microns.

- [c22] 22.The electrolytic reactor according to Claim 17, wherein the catalyst material comprises a size of about 1,400 microns to about 300 microns.
- [c23] 23.The electrolytic reactor according to Claim 17, wherein the catalyst material comprises a size of about 2,800 microns to about 250 microns.
- [c24] 24.The electrolytic reactor according to Claim 17, wherein the central compartment further comprises a cation exchange material, wherein the cation exchange material and the catalyst material are arranged in layers, wherein each one of the layers has a different physical property.
- [c25] 25.The electrolytic reactor according to Claim 17, wherein the central compartment is separated from the anode compartment with a non-permselective membrane.
- [c26] 26.The electrolytic reactor according to Claim 18, wherein the cation exchange material is selected from the group consisting of strong acid polystyrene divinylbenzene crosslinked resins, weak acid polystyrene divinylbenzene crosslinked resins, iminoacetic acid polystyrene divinylbenzene crosslinked chelating selective cation exchange resins, synthetic inorganic cation exchangers and naturally occurring cationic exchangers.
- [c27] 27.The electrolytic reactor according to Claim 20, wherein the catalytic metal oxide is about 0.01 to about 10% by weight of the support.
- [c28] 28.The electrolytic reactor according to Claim 20, wherein the catalytic metal oxide is about 0.05 to about 2% by weight of the support.
- [c29] 29.The electrolytic reactor according to Claim 20, wherein the support is selected from the group consisting of metals, zeolites, anthracite, clinoptilolite, aluminas, silicas, ceramics and carbon.
- [c30] 30.The electrolytic reactor according to Claim 20, wherein the support comprises a ceramic.
- [c31] 31.The electrolytic reactor according to Claim 20, wherein the support comprises a mineral particulate, a binder, silicon carbide, and a parting agent.

[c32] 32.The electrolytic reactor according to Claim 20, wherein the catalytic metal oxide is an oxide of a metal selected from the group consisting of ruthenium, platinum, palladium, osmium, iridium, rhodium, titanium, manganese, lead, zirconium, niobium, tantalum, tungsten, tin and combinations of at least one of the foregoing.

[c33] 33.The electrolytic reactor according to Claim 20, wherein the support comprises a material selected the group consisting of orthoclase, nepheline, hornblende, diopside, titanite, apatite, magnetite, biotite, kaolinite, analcite, plagioclase, orthoclase, feldspar, pyroxene, quartz, perlite, apatite, biotite, pyrite, bentonite, starch, polyvinyl alcohol, vermiculite cellulose gum, polyvinyl acetate, lignosulphonate and combinations comprising at least one or more of the foregoing.

[c34] 34.The electrolytic reactor according to Claim 24, wherein the central compartment comprises a bottom layer consisting essentially of the cation exchange material, an interlayer consisting essentially of a mixture of the cation exchange material and the catalyst material, and an upper layer consisting essentially of the catalyst material.

[c35] 35.The electrolytic reactor according to Claim 24, wherein the cation exchange material has a crosslinking density greater than or equal to about 16%.

[c36] 36.A process for fabricating a ceramic catalyst material, the process comprising:
dissolving a metal oxide precursor into a solution;
coating a ceramic particle with the solution; and
heating the coated ceramic particle to a temperature effective to form a metal oxide.

[c37] 37.The process according to Claim 36, wherein the metal oxide precursor consists of tetraamineplatinum (II) chloride.

[c38] 38.The process according to Claim 36, further comprising adding ions to the solution for increasing an amount of the metal oxide precursor dissolved in the solution.

[c39] 39. A process for generating chlorine dioxide from an alkali metal chlorite solution, the process comprising:
applying a current to an electrolytic reactor, wherein the electrolytic reactor includes an anode, a cathode, and a catalyst material;
flowing an aqueous alkali metal chlorite solution into the electrolytic reactor; and
contacting the alkali metal chlorite solution with the catalyst material to electrocatalytically produce an effluent containing chlorine dioxide.

[c40] 40. The process according to Claim 39, further comprising a cation exchange material.

[c41] 41. The process according to Claim 40, further comprising forming a lower layer consisting essentially of the cation exchange material, at least one intermediate layer consisting essentially of a mixture of the cation exchange material and the catalyst material, and an upper layer consisting essentially of the catalyst material, wherein flowing the aqueous alkali metal chlorite solution comprises flowing the solution from the lower layer to the upper layer.

[c42] 42. The process according to Claim 39, wherein the alkali metal chlorite solution comprises less than about 10,000 milligrams alkali metal chlorite per liter of solution.

[c43] 43. The process according to Claim 39, wherein the alkali metal chlorite solution comprises less than about 5,000 milligrams alkali metal chlorite per liter of solution.

[c44] 44. The process according to Claim 39, wherein the alkali metal chlorite solution comprises less than about 1,500 milligrams alkali metal chlorite per liter of solution.

[c45] 45. A process for generating chlorine dioxide from an alkali metal chlorite solution, the process comprising:
applying a current to an electrolytic reactor including an anode compartment comprising an anode and a catalyst material; and a cathode compartment comprising a cathode;

flowing an aqueous alkali metal chlorite solution into the electrolytic reactor; and

contacting the alkali metal chlorite solution with the catalyst material to electrocatalytically produce an effluent containing chlorine dioxide.

- [c46] 46.The process according to Claim 45, further comprising flowing water into the cathode compartment; generating hydroxyl ions; and passing alkali metal ions from the central compartment into the cathode compartment to produce an effluent of an alkali metal hydroxide.
- [c47] 47.The process according to Claim 45, wherein the alkali metal chlorite solution is selected from the group consisting of sodium chlorite, potassium chlorite, lithium chlorite and combinations of at least one of the foregoing.
- [c48] 48.The process according to Claim 45, wherein the central compartment further comprises a cation exchange material.
- [c49] 49.The process according to Claim 48, wherein the cation exchange material is selected from the group consisting of strong acid polystyrene divinylbenzene crosslinked resins, weak acid polystyrene divinylbenzene crosslinked resins, iminoacetic acid polystyrene divinylbenzene crosslinked chelating selective cation exchange resins, synthetic inorganic cation exchangers, naturally occurring cationic exchangers and combination including at least one of the foregoing.
- [c50] 50. The process according to Claim 45, wherein the central compartment further comprises electrically conductive particles.
- [c51] 51.The process according to Claim 45, wherein the central compartment comprises a bottom layer consisting essentially of the cation exchange material, an interlayer consisting essentially of a mixture of the cation exchange material and the catalyst material, and an upper layer consisting essentially of the catalyst material.
- [c52] 52.The process according to Claim 48, wherein flowing the alkali metal chlorite solution into the central compartment comprises flowing the solution from the

bottom layer to the upper layer.

[c53] 53.The process according to Claim 45, wherein the alkali metal chlorite solution contacts the catalyst material for a time of about 0.1 to about 20 minutes.

[c54] 54.The process according to Claim 45, wherein flowing the alkali metal chlorite solution into the central compartment produces a pressure drop of about 0.1 to about 20 pounds per square inch.

[c55] 55.The process according to Claim 45, wherein the effluent containing the chlorine dioxide has a pH of about 1 to about 5.

[c56] 56.The process according to Claim 45, wherein the effluent containing the chlorine dioxide has a pH of about 2 to about 3.

[c57] 57.The process according to Claim 45, wherein the aqueous alkali metal chlorite solution comprises an alkali metal chlorite concentration less than about 1.5 grams per liter of solution.

[c58] 58.The process according to Claim 45, wherein the catalyst material comprises a shape selected from the group consisting of rods, extrudates, tablets, pills, irregular shaped particles, spheres, spheroids, capsules, discs, pellets and a combination of at least one of the foregoing.

[c59] 59.A process for generating chlorine dioxide from an alkali metal chlorite solution, the process comprising:
applying a current to an electrolytic reactor, wherein the electrolytic reactor includes an anode compartment comprising an anode, a cathode compartment comprising a cathode, and a central compartment disposed between the anode and cathode compartments, wherein the central compartment comprises a catalyst material;
flowing water into the anode compartment and generating hydrogen atoms;
passing the hydrogen atoms into the central compartment;
flowing the alkali metal chlorite solution into the central compartment; and
contacting the alkali metal chlorite solution with the catalyst material to produce an effluent containing chlorine dioxide.

[c60] 60.The process according to Claim 59, further comprising forming in the central compartment a lower layer consisting essentially of the cation exchange material, at least one intermediate layer consisting essentially of a mixture of the cation exchange material and the catalyst material, and an upper layer consisting essentially of the catalyst material, wherein flowing the aqueous alkali metal chlorite solution into the central compartment comprises flowing the solution from the lower layer to the upper layer.

[c61] 61.The process according to Claim 59, wherein the anode compartment and the cathode compartment comprise a cation exchange material.

[c62] 62.A catalyst material comprising a catalytic metal oxide and a support, wherein the catalytic metal oxide is a combination of an oxide of a metal selected from the group consisting of ruthenium, platinum, palladium, osmium, iridium, and rhodium, and an oxide of a metal selected from the group consisting of titanium, lead, manganese, zirconium, niobium, tantalum, tungsten, tin and alloys of at least one of the foregoing.

[c63] 63. The catalyst material according to Claim 62, wherein the support is selected from the group consisting of metals, zeolites, anthracite, clinoptilolite, aluminas, silicates, and ceramics.

[c64] 64.The catalyst material according to Claim 62, wherein the support comprises a ceramic.

[c65] 65.An electrolytic reactor for the oxidation of chlorite ions in an aqueous solution, the reactor comprising:
an anode compartment comprising an anode;
a cathode compartment comprising a cathode; and
a central compartment disposed between the anode and cathode compartments, wherein the central compartment comprises a catalyst material, and wherein a non-permselective membrane separates the anode compartment from the central compartment.

[c66] 66.The electrolytic reactor according to Claim 65, wherein the non-permselective membrane comprises a porous structure.

[c67] 67. The electrolytic reactor according to Claim 65, wherein the non-permselective membrane comprises a pore size greater than or equal to about 0.25 millimeters to less than or equal to about 2.8 millimeters.

[c68] 68. The electrolytic reactor according to Claim 65, wherein the non-permselective membrane comprises a pore size greater than or equal to about 0.3 millimeters to less than or equal to about 1.4 millimeters.

[c69] 69. The electrolytic reactor according to Claim 65, wherein the non-permselective membrane comprises a pore size greater than or equal to about 0.4 millimeters to less than or equal to about 0.6 millimeters.

[c70] 70. The electrolytic reactor according to Claim 65, wherein the non-permselective membrane comprises a polyolefin or a halogenated polymer.

[c71] 71. The electrolytic reactor according to Claim 65, wherein the non-permselective membrane comprises fluorinated poly(vinyl) polymers or chlorinated polymers.

[c72] 72. The electrolytic reactor according to Claim 70, wherein the fluorinated polymer comprises polytetrafluoroethylene, fluorinated ethylene propylene copolymers, perfluoropropylalkoxy copolymers, perfluormethylalkoxy copolymers, polychlorotrifluoroethylene copolymers, ethylene tetrafluoroethylene polymers, or polyvinylidene fluoride polymers.

[c73] 73. The electrolytic reactor according to Claim 65, wherein the central compartment further comprises a cation exchange material, wherein the cation exchange material and the catalyst material are arranged in layers, wherein each one of the layers has a different physical property.

[c74] 74. The electrolytic reactor according to Claim 73, wherein the cation exchange material forms a bottom layer, a mixture of the cation exchange material and the catalyst material forms an interlayer, and the catalyst material forms an upper layer.

[c75] 75. The electrolytic reactor according to Claim 65, wherein the catalyst material comprises a catalytic metal oxide and a support.

[c76] 76.The electrolytic reactor according to Claim 75, wherein the catalytic metal oxide is an oxide of a metal selected from the group consisting of ruthenium, platinum, palladium, osmium, iridium, rhodium, titanium, manganese, lead, zirconium, niobium, tantalum, tungsten, tin and combinations of at least one of the foregoing, and wherein the support is selected from the group consisting of metals, zeolites, anthracite, clinoptilolite, aluminas, silicas, ceramics and carbon.

[c77] 77.A process for generating chlorine dioxide from a dilute alkali metal chlorite solution, the process comprising:
applying a current to an electrolytic reactor, wherein the electrolytic reactor comprises an anode compartment comprising an anode, a cathode compartment comprising a cathode, and a central compartment disposed between the anode and cathode compartments, wherein the central compartment comprises a catalyst material, and wherein a non-permselective membrane separates the anode compartment from the central compartment; flowing water into the anode compartment and generating hydrogen atoms; passing the hydrogen atoms into the central compartment; flowing the dilute alkali metal chlorite solution into the central compartment; and
contacting the dilute alkali metal chlorite solution with the catalyst material to produce an effluent containing chlorine dioxide.

[c78] 78.The process according to Claim 77, wherein the central compartment further comprises a cation exchange material, wherein the cation exchange material and the catalyst material are arranged in layers, wherein each one of the layers has a different physical property.

[c79] 79.The process according to Claim 77, wherein the dilute alkali metal chlorite solution comprises less than about 10,000 milligrams alkali metal chlorite per liter of solution.

[c80] 80.The process according to Claim 77, wherein the dilute alkali metal chlorite comprises less than about 5,000 milligrams alkali metal chlorite per liter of solution.

[c81] 81.The process according to Claim 77, wherein the dilute alkali metal chlorite solution comprises less than about 1,500 milligrams alkali metal chlorite per liter of solution.